Creating a sustainable national index for social, environmental and economic productivity

Introduction

Sustainability has recently been recognised as one of the major issues to confront mankind on planet earth. Sustainable development, according to the UN's Brundtland commission "is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (*Report of the World Commission on Environment and Development: Our Common Future, Chapter 2: Towards Sustainable Development (Annex to document A/42/427)*, 2005). The United Nations General Assembly has identified "economic development, social development and environmental protection as interdependent and mutually reinforcing pillars" of sustainability (*Resolution adopted by the General Assembly 60/1. 2005 World Summit Outcome*, 2005 p. 12). While such as the Club of Rome report in the 1970s (Meadows, Meadows, Randers, & Behrens III, 1972) highlighted the unsustainability of then current rates of resource depletion, man-made climate change was not recognised as an issue until more recently and its existence is still challenged by some.

This recent recognition of the impact of climate change demonstrates the complexity of the interaction between social, environment and economic factors. (Even those who are 'man-made climate change nay-sayers' – seeing the symptoms of rising global temperatures purely as evidence of a natural cyclical climate change phenomenon - recognise that sustainability is important in terms of husbanding vital and diminishing fossil fuels.)

Elkington (1999) coined the term 'triple bottom line' to represent this emerging focus on the three factors of social, environmental and economic added value. This concept has been modified over time and is now often summarised as People, Planet, Profit.

More recently, these social, environmental and economic factors have been addressed by the World Confederation of Productivity Science (WCPS), a global think-tank on productivity based in Montreal, Canada (http://www.wcps.info/). The WCPS became convinced that these three factors had to be viewed holistically and had to be viewed as a business issue, not as an 'add-on' issue of corporate social responsibility. At the World Productivity Congress in South Africa in 2008, the WCPS launched their concept of SEE productivity, reflecting this wider recognition that, to be sustainable in the longer-term, organisations, nations and regions need to improve all of social, environmental and economic productivities so that their operations are socially equitable, environmentally bearable and economically viable (see Figure 1).

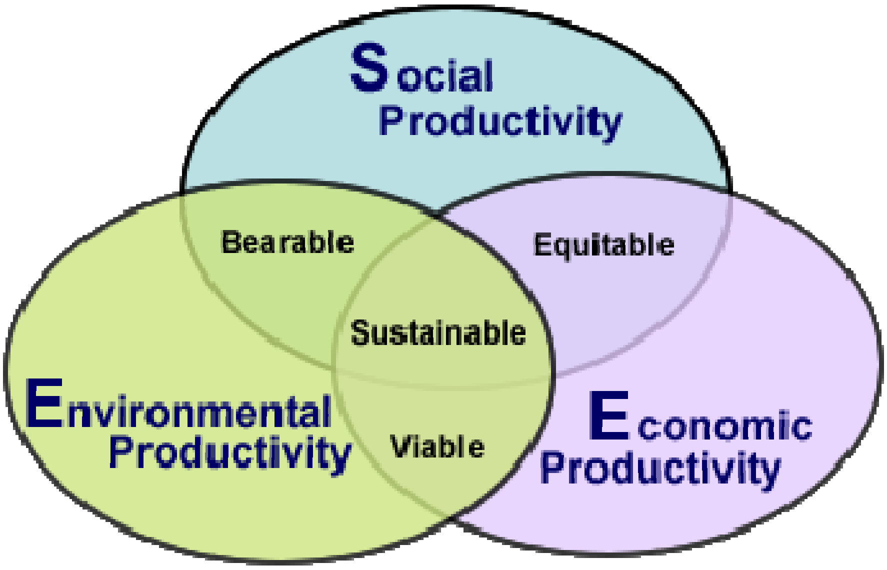

Figure 1: SEE productivity

The WCPS understands that if collectively the world is going to address this important topic, then absolute or relative measures of these productivities would be helpful in:

- understanding and diagnosing current behaviours and current performance;
- comparing current performance to 'best in class'; and
- driving efforts to improve performance.

It therefore sought to identify ways in which SEE productivity can be measured or assessed. (There are numerous measures for the individual components of SEE productivity but there seems to be no consensus on a measurement or assessment model representing the combined factors.)

Further, the WCPS identified that since much of the needed action has to be at the level of governments of individual countries, often acting in concert with other countries, then performance measures are required at the country level and above.

Any measurement or assessment regime for SEE productivity (like all effective measurement regimes) should:

- Provide information in a timely fashion, within the 'time span of discretion' of those able to influence SEE activities
- Provide a balanced view so that subsequent improvement actions are not sub-optimal
- Present information clearly and concisely so that the underlying messages are themselves clear

- Involve the use of measures that are deemed credible by both those being measured and by those using the measures as a means of decision-making
- Be cost effective

WCPS has within its structure, the World Academy of Productivity Science, a body that recognises individuals as having made a significant contribution to the development of, or the promotion of, productivity science. WCPS logically therefore approached Fellows of the Academy to contribute to the discussion and debate.

John Heap, the President of WCPS, presented a very early model for a SEE index at the World Productivity congress in Turkey in 2010. This paper builds on the discussion that arose from that presentation and is an attempt to take forward the concept and build a simple and up to date, but robust and rigorous, social, environmental and economic (SEE) index that supports progress towards sustainability.

Methodology

The OECD Handbook (*Handbook on constructing composite indicators: Methodology and user guide*, 2008) describes how "a composite indicator is formed when individual indicators are compiled into a single index on the basis of an underlying model". The idea is that the composite index captures multi-dimensional concepts that cannot be handled by a single indicator and is therefore relevant to the situation in this paper of combining three, separate aspects of country performance.

The OECD Handbook suggests a ten-step guide to building a composite index (or indicator):

1. Theoretical framework
2. Data selection
3. Imputation of missing data
4. Multivariate analysis
5. Normalisation
6. Weighting and aggregation
7. Robustness and sensitivity analysis
8. Back to the detail
9. Links to other indicators
10. Visualisation of the results

In general these ten steps will be used to carry forward our discussion of the construction of the SEE Index. Step 4, the multivariate analysis will be deferred until after the normalisation and integrated with step 8, "back to the detail". Similarly we will combine steps 8 and 9 while the results will be presented visually throughout the various steps and therefore a separate visualisation section is not required.

Theoretical framework

The idea is to combine together the three main issues of current interest, namely social, environmental and economic performance to form a SEE index.

It is a truism to state that our modern society depends on economic productivity but attention is drawn increasingly in the media to what many see as the environmental "price" that has been, and is being, paid for economic performance. Increasingly informed consumers make buying decisions on the basis of factors other than (or in addition to) cost/price levels.

Debate continues on the extent to which these three aspects might be traded off, or not, depending on one's point of view but few would dispute that these three interacting variables are of prime concern to organisations, countries and regions. Bringing the three together in the one index enables us to examine the differential positions of countries and to track changes over time.

To represent economic performance we have selected the most common measure of national productivity, GDP per capita.

For environmental performance we focus on the key issue that has attracted attention in recent times, e.g. in recent environmental summits, that of carbon emissions. The chosen measure is of metric tonnes of CO2 produced per capita per year.

A measure of social performance is not as easy to determine; indeed a single measure for this concept is not easily to hand and raises the need for a composite measure. This means the (overall) composite index becomes a hierarchical index with at least two levels of aggregation. However, inspiration for the constituents of the social index comes from the UN Human Development Index (HDI - http://hdr.undp.org/en/statistics/hdi/) which combines living standards (i.e. economic), health and education indices. The latter index combines two measures (i) mean years of schooling for adults aged 25 years and (ii) expected years of schooling for children of school-going age, to provide a measure of educational progress in the country.

Because the proposed overall SEE index has a separate economic index, the economic element of the UN HDI can be discounted and a social index formed by combining the factors that make up the health and education indices; i.e. life expectancy and the two educational components (see Figure 2).

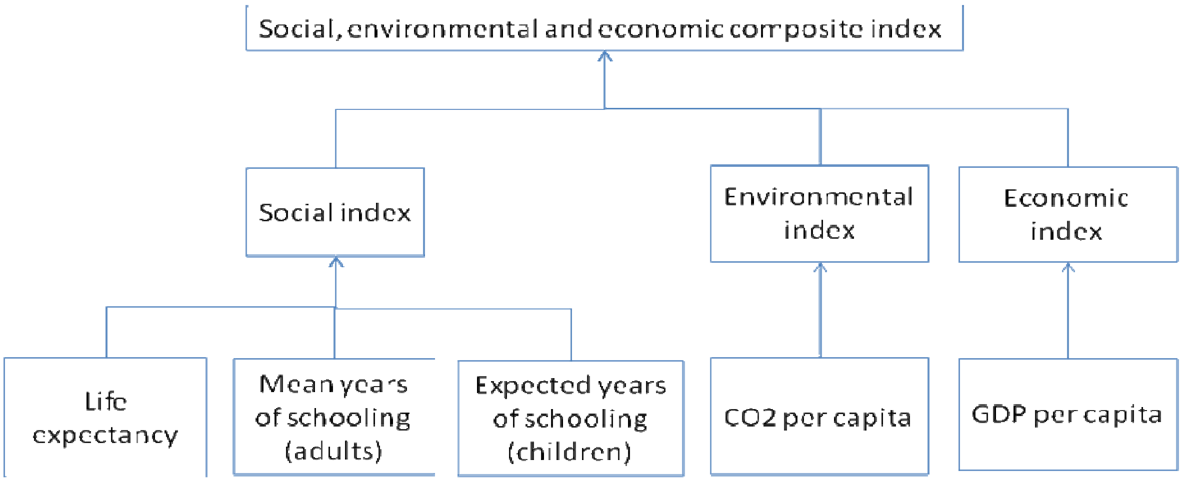

Figure 2

Data selection

The UN website is used as the main source for the data given its comprehensiveness and reliability. The constituent variables and their sources are given in Table 1.

Table 1: Constituent variables and data sources

Component	**Constituent Variables**	**Source**
Social	Life expectancy at birth	United Nations Statistics Division http://unstats.un.org/unsd/default.htm
	Mean years of schooling (adult)	UN (as above)
	Expected years of schooling (children)	UN (as above)
Environmental	Metric tonnes of CO_2 per capita per year	US Energy Information Administration http://www.eia.gov/
Economic	Gross domestic product US dollars at current prices per capita per year	UN (as above)
Population	Country population in millions	UN (as above)

The latest time series available for the CO_2 emissions was 2009 while the other data series were available for 2010. To use a consistent base year across all measures, data for 2009 were taken as the base for all the variables.

Missing Data

Since the source data comprise times series, the intended strategy was to use the single imputation method and substitute the most recently available value in place of a missing value. If no previous value were available then a cross-sectional approach would be taken and a representative value such as the arithmetic mean of the distribution would ne substituted in place of the missing value (see p. 55 of the OECD Handbook). Table 2 shows the level of missing data for the raw data is not substantial.

Table 2: Descriptive statistics for constituent variables pre- and post-transformation

Variable	Mean	Standard deviation	Skewness	P value K-S	n
Life expectancy - data	68.99	10.07	-0.825	.000 ***	194
Life expectancy - index	1.00	0.33	.526	.108	194
Mean years of schooling - data	7.52	3.01	-.326	.08	173
Mean years of schooling - index	1.00	0.33	-.345	.137	194
Expected years of schooling - data	12.08	3.22	-.406	.536	190
Expected years of schooling - index	1.00	0.33	-.410	.408	194
Social index	1.00	0.30	-.117	.175	194
Carbon per capita - data	5.56	9.07	4.338	.000 ***	186
Carbon per capita – environment index	1.00	0.33	-.536	.145	194
GDP per capita - data	13,113	22,903	3.904	.000 ***	194
GDP per capita – economic index	1.00	0.33	.115	.414	194
“Raw” social, environment & economic index	1.00	0.13	.340	.758	194
Social, environment & economic index	1.00	0.33	.339	.767	194
Population	35.78	135.64	8.497	.000 ***	194

K-S stands for the Kolmogorov-Smirnov test of the data fitting a normal distribution

Multivariate analysis

In our study we carried out this analysis on the normalised variables and so we report the results of this analysis after we have described the results of the normalisation process.

Normalisation

For each constituent variable a two-step process was followed to normalise the data. First the descriptive statistics and distribution of the variable were examined and, where necessary the distribution transformed to approximate to a normal distribution. Second the distributions were then standardised to have a mean of 1 and a standard deviation of 1/3.

This initial transformation is common practice in statistical work and the OECD Handbook (e.g. p. 84) advises that constituent variables should be dealt with prior to constructing the composite index. Typically where a distribution is skewed its scale requires transformation to yield a symmetrical shape, otherwise changes in values at different points on the scale have disproportionate impacts. A common problem with many economic variables (and other data) is that they follow lognormal distributions that are positively skewed. This is the case with variables such as salary, GDP and other similar data. Three out of the five variables in this study were heavily skewed and non-normal (see Table 2), and therefore needed to be mathematically transformed – two variables did not require transformation. As an example, Figure 3 shows the highly-positive-skewed histogram for GDP per capita while Table 2 gives the descriptive statistics before and after transformation of the constituent variables. Figure 3 also shows the variable after transformation.

All three heavily-skewed variables were transformed using a log base 10 transformation. Such transformations do not alter the sequence of countries and are more flexible that simply ranking the data. Table 2 shows the results of the Kolmogorov-Smirnov test for normality on the pre- and post-transformed variables; the tests are significant on the three skewed-variables demonstrating the need for transformation. On the other hand the tests for the transformed variables are not significant demonstrating that these conform to a normal distribution.

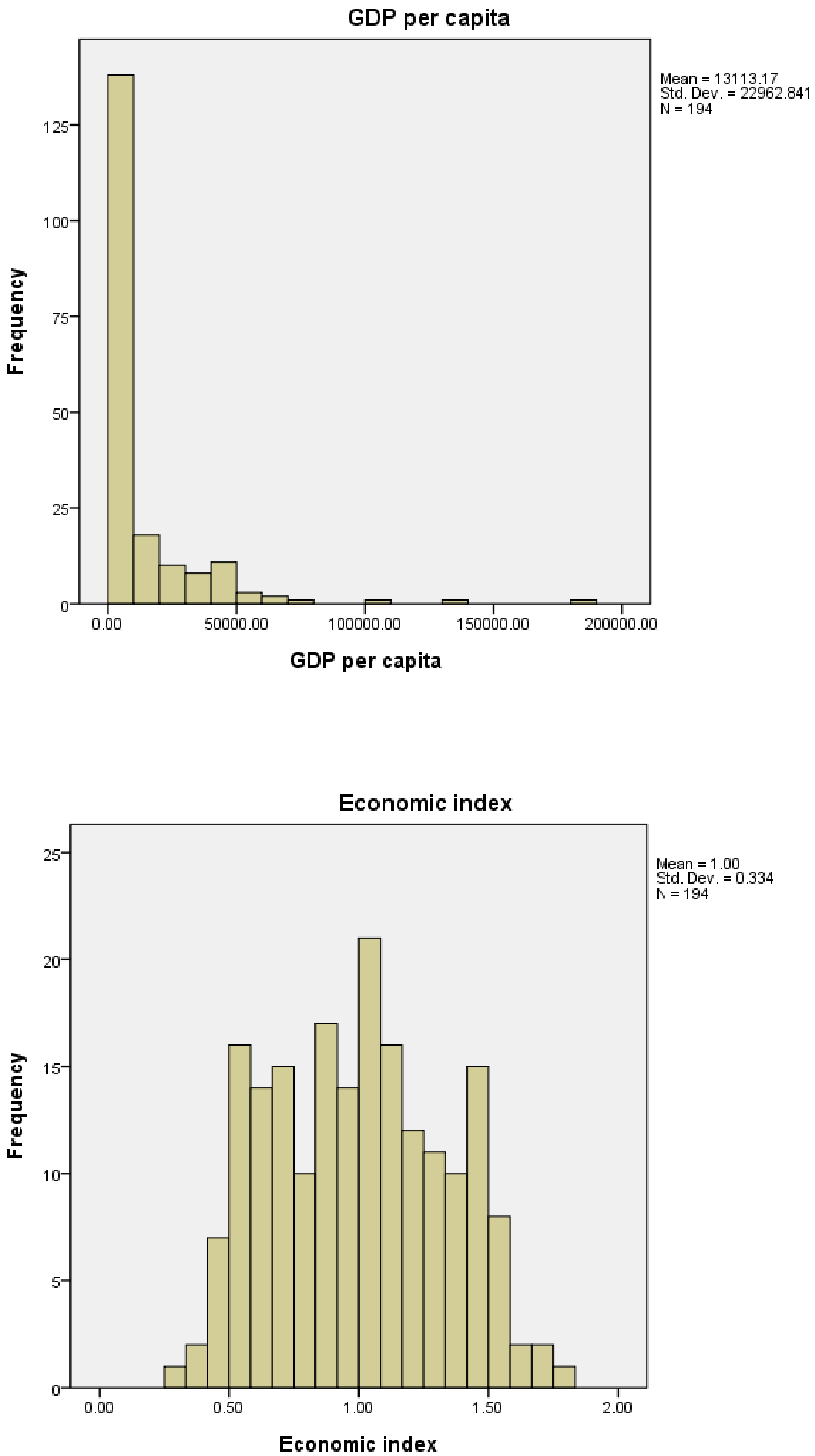

Figure 3: Histogram for GDP per capita before and after transformation to economic index

The need for the second step, i.e. standardisation, can be seen in the different mean values of the variables. For example, (transformed) GDP per capita has a mean of 3.629 while for (transformed) CO_2 per capita the mean is 1.413 If these values were left as they are and the variables combined on an equally-weighted basis then the GDP variable would have an impact that was on average about 2.5-times (i.e. 3.629÷1.413) that of the CO_2 variable. So the scales of these distributions need modification to bring the mean values in to alignment. This alignment can be achieved in different ways; the one chosen here is to standardise the distribution so that all constituent variables have a mean of 1. Similarly the standard deviations have to be standardised, otherwise a change in one constituent variable would have a different impact on the composite index compared to the same change in another variable. In this case the variables are standardised to have standard deviations of 1/3 since for a normal distribution 99.7% of values fall within plus or minus three standard deviations from the mean value. In other words this standardisation to a normal distribution (1,1/3) means that the variable will encompass a range of 0 to 2 centred on 1.

Life expectancy

A full set of data were available so no missing value imputation was required. To counter the significant non-normality of the data (see Table 2) and the negative skewness, the data were first reflected to give positive skew by subtracting the life expectancy from the maximum life expectancy and then adding one to avoid a minimum value of zero. A log 10 transformation then converted the series into a normal distribution and finally the distribution was standardised to a mean of one and a standard deviation of one third.
The process of normalisation, comprising the two step process of (1) transformation of variable x to variable t and (2) standardisation of variable t to s, is specified in the following equations:

$$s = 1 + ((\log(Max_x - Min_x) - \log(Max_x - x) - Mean_t) / (3 * Std\_dev_t))$$
$$= 1 + ((\log(84 - 44) - \log(84 - x) - 0.53750) / (3 * 0.33498))$$

Mean School Years

The raw data set had a substantial number of missing values (21 out of the 194) but was normal (for Kolmogorov-Smirnov p was .08 for the sample of 173, i.e. prior to missing value imputation). Mean values were substituted for the missing values and the distribution standardised to a mean of one and the standard deviation of one third.

$$s = 1 + ((x - Mean_t) / (3 * Std\_dev_t))$$
$$= 1 + ((x - 7.520465) / (3 * 2.842375))$$

Expected School Years

Whereas the Mean School Years variable measures the schooling for adults of age 25 and above, this variable measures the expected length of schooling for children old enough to enter primary school. Virtually a full set of data was available – the four missing values out of the 194 were dealt with by mean imputation. The distribution prior to mean imputation was normal (for the Kolmogorov-Smirnov test *p* was 0.536) and therefore the standard transformation to a mean of 1 and standard deviation of one third was applied.

$$s = 1 + ((x - Mean_t) / (3 * Std\_dev_t))$$
$$= 1 + ((x - 12.0834) / (3 * 3.176925))$$

Carbon per capita

Eight values were missing from the 2009 data set for the 194 countries. The data were highly skewed and therefore the median value was substituted for missing values rather than the mean. To counteract the significant lack of normality the data were log transformed and also reflected because high values of carbon per capita represent poor performance[1].

$$s = 1 + ((\log(Max_x - Min_x) - \log(1 + x) - Mean_t) / (3 * Std\_dev_t))$$
$$= 1 + ((\log(100 - 0) - \log(1 + x) - 1.412671) / (3 * 0.41214))$$

GDP per capita

A full set of values were available for this variable. Log transformation was needed to counter the positively-skewed, significant non-normality of the data.

$$s = 1 + ((\log(x) - Mean_t) / (3 * Std\_dev_t))$$
$$= 1 + ((\log(x) - 3.629215) / (3 * 0.682527))$$

Weighting and aggregation

According to the OECD Handbook, most composite indicators rely on equal weighting, i.e. the constituent variables are given the same weight. In this situation the equal weighting approach is suggested; i.e. the three components of the social index are equally-weighted and the three components of the SEE Index are also given equal weighting. While the Handbook lists a number of methods, the two main aggregation approaches are linear and geometric, i.e. an additive model vs. a multiplicative one. The Handbook points out that the linear approach is best when individual indicators are on the same measurement scale, as they are here with the normalised indices. Also linear aggregation means that individual indicators contribute to the composite index in proportion to the weights while geometric aggregation means that those countries with higher scores have a greater impact on the composite. However, the Handbook basically points out that there is no

[1] For the other four variables a high value represents good performance.

"objective" way to determine weights and aggregation methods, in other words it is futile to believe there is one, correct way of designing a composite index. For both the social index and the SEE Index we use the linear aggregation method.

So the equation for the social index i is:

$$i = (s_1 + s_2 + s_3) / 3$$

For the social index the results of this equally-weighted aggregation is a distribution whose mean is 1.0 and standard deviation of 0.30 Ideally we would look to have a standard deviation of 1/3 to make the overall social index directly comparable on variability to that of its component indices and of the other two constituent indices aggregated within the SEE index. However, the closeness of 0.30 to 0.333 leads to accepting the social index as it is without further standardisation.

However, for the un-standardised SEE index the standard deviation is 0.13. I.e. combining the three components where each has a standard deviation of 1/3 produces an overall index with reduced variability compared to the component parts. The reason for this is explained below when the correlations of the various indices are examined. An overall index with the same variability as the three component indices would enable direct comparison between the three components and the overall index; so the final step is to standardise the "raw" index to give the final SEE index I with a standard deviation of 1/3. The two steps involved here are:

$$i = (s_1 + s_2 + s_3) / 3$$
$$I = 1 + (i - Mean_i)/(3 * std\_dev_i)$$
$$\text{i.e. } I = 1 + (I - 1)/(3 * 0.13074)$$

The values of the final SEE index for the 194 countries are given in Table 3 along with the values of the composite indices and of the raw SEE index. While Table 3 is organised in alphabetic order by country, Table 4 presents the SEE index in rank order.

Table 3: Country indices and clusters in alphabetic order of country name

Country	Social Index	Env. Index	Econ. Index	Raw SEE Index	SEE Index	SEE Rank	Cluster H, M, L
Afghanistan	0.509	1.465	0.526	0.833	0.575	175	L
Albania	1.150	1.146	0.978	1.091	1.233	51	M
Algeria	1.010	0.960	0.988	0.986	0.965	102	M
Andorra	1.266	1.030	1.494	1.263	1.671	7	H
Angola	0.445	1.103	0.828	0.792	0.470	189	L
Antigua and Barbuda	1.001	0.702	1.235	0.979	0.947	108	M
Argentina	1.231	0.904	1.125	1.087	1.221	52	M
Armenia	1.144	0.925	0.909	0.993	0.981	100	M
Australia	1.703	0.412	1.512	1.209	1.532	15	H
Austria	1.352	0.687	1.503	1.181	1.460	19	H
Azerbaijan	1.117	0.883	1.029	1.010	1.025	90	M

Country	Social Index	Env. Index	Econ. Index	Raw SEE Index	SEE Index	SEE Rank	Cluster H, M, L
Bahamas	1.143	0.459	1.336	0.979	0.947	109	H
Bahrain	1.199	0.148	1.370	0.906	0.760	145	H
Bangladesh	0.691	1.367	0.566	0.875	0.681	154	L
Barbados	1.199	0.853	1.253	1.102	1.260	46	M
Belarus	1.125	0.778	1.038	0.980	0.949	106	M
Belgium	1.409	0.543	1.497	1.150	1.382	27	H
Belize	1.140	0.983	1.005	1.043	1.109	68	M
Benin	0.647	1.359	0.629	0.878	0.689	153	L
Bhutan	0.912	1.337	0.815	1.022	1.055	77	L
Bolivia	1.053	1.165	0.812	1.010	1.025	89	M
Bosnia and Herzegovina	1.120	0.911	1.013	1.015	1.037	84	M
Botswana	0.928	1.059	1.071	1.019	1.049	78	M
Brazil	1.045	1.076	1.137	1.086	1.219	53	M
Brunei Darussalam	1.143	0.414	1.387	0.981	0.952	105	H
Bulgaria	1.163	0.783	1.088	1.011	1.029	87	M
Burkina Faso	0.397	1.445	0.553	0.798	0.485	187	L
Burundi	0.569	1.461	0.291	0.774	0.423	191	L
Cambodia	0.759	1.391	0.626	0.925	0.809	133	L
Cameroon	0.703	1.357	0.720	0.926	0.812	131	L
Canada	1.479	0.477	1.474	1.143	1.365	28	H
Cape Verde	0.804	1.293	0.935	1.011	1.027	88	L
Central African Republic	0.475	1.455	0.522	0.817	0.534	180	L
Chad	0.393	1.465	0.588	0.815	0.529	181	L
Chile	1.281	0.913	1.173	1.122	1.311	36	M
China	0.984	0.800	0.974	0.919	0.795	136	M
Colombia	1.044	1.138	1.035	1.073	1.185	55	M
Comoros	0.704	1.411	0.641	0.919	0.793	138	L
Congo	0.701	1.143	0.904	0.916	0.786	140	L
Congo (Democratic Republic)	0.535	1.461	1.176	1.057	1.146	64	L
Costa Rica	1.138	1.149	1.086	1.124	1.317	34	M
Côte d'Ivoire	0.514	1.378	0.712	0.868	0.663	159	L
Croatia	1.179	0.858	1.257	1.098	1.249	47	M
Cuba	1.413	1.020	1.052	1.162	1.412	22	M
Cyprus	1.293	0.678	1.411	1.127	1.325	32	H
Czech Republic	1.369	0.655	1.310	1.111	1.284	44	H
Denmark	1.384	0.666	1.549	1.199	1.509	16	H
Djibouti	0.471	1.042	0.708	0.740	0.338	194	L
Dominica	1.090	1.097	1.061	1.083	1.211	54	M
Dominican Republic	0.971	1.083	1.017	1.024	1.061	76	M
Ecuador	1.084	1.093	0.997	1.058	1.148	62	M
Egypt	0.892	1.041	0.866	0.933	0.830	128	M
El Salvador	0.992	1.235	0.954	1.060	1.154	60	M
Equatorial Guinea	0.623	0.733	1.300	0.885	0.708	150	M

Country	Social Index	Env. Index	Econ. Index	Raw SEE Index	SEE Index	SEE Rank	Cluster H, M, L
Eritrea	0.666	1.429	0.481	0.859	0.640	165	L
Estonia	1.320	0.537	1.258	1.038	1.097	71	H
Ethiopia	0.501	1.448	0.467	0.805	0.504	184	L
Fiji	1.131	1.064	0.965	1.053	1.136	65	M
Finland	1.434	0.635	1.499	1.189	1.482	18	H
France	1.470	0.777	1.482	1.243	1.619	9	H
Gabon	0.915	0.986	1.124	1.008	1.021	91	M
Gambia	0.566	1.397	0.563	0.842	0.597	170	L
Georgia	1.191	1.206	0.889	1.096	1.244	49	M
Germany	1.462	0.656	1.478	1.199	1.507	17	H
Ghana	0.771	1.372	0.594	0.912	0.776	143	L
Greece	1.401	0.654	1.407	1.154	1.393	26	H
Grenada	1.092	1.008	1.077	1.059	1.150	61	M
Guatemala	0.792	1.259	0.900	0.984	0.958	104	L
Guinea	0.532	1.432	0.533	0.832	0.573	176	L
Guinea-Bissau	0.528	1.383	0.553	0.821	0.544	179	L
Guyana	0.990	1.088	0.902	0.993	0.983	99	M
Haiti	0.615	1.408	0.593	0.872	0.674	156	L
Honduras	0.932	1.230	0.832	0.998	0.995	95	M
Hong Kong, China (SAR)	1.438	0.569	1.414	1.140	1.357	30	H
Hungary	1.289	0.846	1.235	1.123	1.314	35	H
Iceland	1.572	0.599	1.462	1.211	1.538	12	H
India	0.734	1.170	0.708	0.871	0.671	158	L
Indonesia	0.930	1.124	0.874	0.976	0.938	110	M
Iran (Islamic Republic)	1.038	0.747	1.028	0.938	0.842	124	M
Iraq	0.793	0.941	0.653	0.796	0.479	188	L
Ireland	1.520	0.674	1.519	1.237	1.605	10	H
Israel	1.488	0.641	1.392	1.174	1.443	20	H
Italy	1.438	0.744	1.449	1.210	1.536	13	H
Jamaica	1.060	0.890	1.015	0.988	0.970	101	M
Japan	1.607	0.679	1.474	1.253	1.646	8	H
Jordan	1.081	0.972	0.985	1.013	1.032	86	M
Kazakhstan	1.144	0.574	1.105	0.941	0.849	123	H
Kenya	0.756	1.386	0.629	0.923	0.804	134	L
Kiribati	0.957	1.345	0.754	1.019	1.047	79	L
Korea (Democratic People's Rep.)	0.950	0.946	0.545	0.814	0.525	182	M
Korea (Republic)	1.464	0.605	1.296	1.122	1.311	37	H
Kuwait	1.049	0.252	1.457	0.919	0.794	137	H
Kyrgyzstan	1.039	1.225	0.654	0.973	0.931	112	L
Lao People's Democratic Republic	0.713	1.411	0.666	0.930	0.822	130	L
Latvia	1.230	0.923	1.211	1.121	1.309	38	M
Lebanon	1.049	0.937	1.138	1.042	1.106	69	M
Lesotho	0.692	1.429	0.640	0.920	0.797	135	L

Country	Social Index	Env. Index	Econ. Index	Raw SEE Index	SEE Index	SEE Rank	Cluster H, M, L
Liberia	0.705	1.414	0.368	0.829	0.564	177	L
Libyan Arab Jamahiriya	1.163	0.677	1.162	1.001	1.002	94	H
Liechtenstein	1.337	1.030	1.732	1.366	1.934	1	H
Lithuania	1.260	0.881	1.205	1.115	1.294	41	M
Luxembourg	1.286	0.381	1.687	1.118	1.301	40	H
Madagascar	0.743	1.426	0.522	0.897	0.738	147	L
Malawi	0.617	1.445	0.450	0.837	0.585	173	L
Malaysia	1.117	0.827	1.104	1.016	1.041	81	M
Maldives	0.892	1.055	0.994	0.980	0.949	107	M
Mali	0.454	1.455	0.611	0.840	0.591	172	L
Malta	1.322	0.715	1.323	1.120	1.306	39	H
Marshall Islands	1.108	1.030	0.907	1.015	1.038	83	M
Mauritania	0.586	1.253	0.662	0.834	0.577	174	L
Mauritius	1.012	0.943	1.097	1.017	1.044	80	M
Mexico	1.149	0.910	1.133	1.064	1.163	58	M
Micronesia (Federated States)	1.000	1.030	0.881	0.971	0.925	113	M
Moldova (Republic)	1.040	1.135	0.779	0.985	0.961	103	M
Monaco	1.254	1.030	1.801	1.362	1.922	2	H
Mongolia	1.023	1.043	0.789	0.952	0.877	120	M
Montenegro	1.229	1.006	1.091	1.109	1.277	45	M
Morocco	0.807	1.203	0.914	0.975	0.935	111	M
Mozambique	0.454	1.438	0.508	0.800	0.491	186	L
Myanmar	0.667	1.399	0.487	0.851	0.621	167	L
Namibia	0.888	1.097	1.001	0.996	0.989	97	M
Nauru	1.015	0.374	1.047	0.812	0.521	183	H
Nepal	0.661	1.435	0.517	0.871	0.671	157	L
Netherlands	1.464	0.504	1.513	1.160	1.408	23	H
New Zealand	1.631	0.657	1.395	1.227	1.580	11	H
Nicaragua	0.892	1.276	0.716	0.961	0.902	117	L
Niger	0.343	1.445	0.466	0.751	0.365	193	L
Nigeria	0.625	1.328	0.717	0.890	0.720	148	L
Norway	1.571	0.685	1.619	1.292	1.743	3	H
Occupied Palestinian Territories	1.052	1.269	0.759	1.026	1.068	75	M
Oman	1.019	0.463	1.316	0.933	0.829	129	H
Pakistan	0.652	1.274	0.667	0.865	0.655	160	L
Palau	1.265	1.030	1.180	1.158	1.404	24	M
Panama	1.168	0.870	1.110	1.049	1.126	66	M
Papua New Guinea	0.535	1.267	0.727	0.843	0.599	169	L
Paraguay	0.998	1.303	0.871	1.057	1.146	63	M
Peru	1.151	1.184	1.007	1.114	1.291	42	M
Philippines	1.019	1.280	0.811	1.037	1.094	73	M
Poland	1.254	0.726	1.207	1.063	1.159	59	H
Portugal	1.253	0.830	1.346	1.143	1.364	29	H

Country	Social Index	Env. Index	Econ. Index	Raw SEE Index	SEE Index	SEE Rank	Cluster H, M, L
Qatar	1.062	-0.068	1.593	0.862	0.649	163	H
Romania	1.220	0.934	1.122	1.092	1.235	50	M
Russian Federation	1.065	0.596	1.152	0.938	0.841	125	H
Rwanda	0.630	1.451	0.557	0.879	0.692	152	L
Saint Kitts and Nevis	1.011	0.787	1.192	0.997	0.992	96	M
Saint Lucia	1.053	1.028	1.054	1.045	1.115	67	M
Saint Vincent and the Grenadines	1.042	1.032	1.042	1.038	1.098	70	M
Samoa	0.997	1.274	0.920	1.064	1.163	57	M
San Marino	1.228	1.030	1.539	1.266	1.677	5	H
Sao Tome and Principe	0.742	1.257	0.749	0.916	0.785	141	L
Saudi Arabia	1.063	0.431	1.258	0.917	0.789	139	H
Senegal	0.553	1.328	0.696	0.859	0.641	164	L
Serbia	1.150	0.807	1.059	1.005	1.013	93	M
Seychelles	1.102	0.476	1.167	0.915	0.783	142	H
Sierra Leone	0.482	1.394	0.494	0.790	0.465	190	L
Singapore	1.303	0.220	1.461	0.995	0.986	98	H
Slovakia	1.292	0.765	1.283	1.113	1.289	43	H
Slovenia	1.331	0.678	1.370	1.126	1.322	33	H
Solomon Islands	0.718	1.323	0.759	0.933	0.830	127	L
Somalia	0.486	1.445	0.372	0.768	0.407	192	L
South Africa	0.922	0.660	1.062	0.881	0.698	151	M
Spain	1.456	0.739	1.432	1.209	1.533	14	H
Sri Lanka	1.048	1.310	0.851	1.070	1.178	56	M
Sudan	0.435	1.383	0.749	0.856	0.632	166	L
Suriname	0.951	0.893	1.062	0.969	0.921	114	M
Swaziland	0.747	1.226	0.901	0.958	0.893	119	L
Sweden	1.484	0.813	1.495	1.264	1.673	6	H
Switzerland	1.482	0.792	1.578	1.284	1.723	4	H
Syrian Arab Republic	0.867	1.024	0.884	0.925	0.809	132	M
Tajikistan	1.010	1.263	0.622	0.965	0.911	116	L
Tanzania (United Republic)	0.542	1.423	0.556	0.840	0.593	171	L
Thailand	0.969	0.924	0.981	0.958	0.893	118	M
The former Yugoslav Rep. of Macedonia	1.056	0.943	1.019	1.006	1.015	92	M
Timor-Leste	0.688	1.319	0.582	0.863	0.650	162	L
Togo	0.735	1.347	0.537	0.873	0.676	155	L
Tonga	1.161	1.186	0.943	1.097	1.247	48	M
Trinidad and Tobago	1.011	0.180	1.278	0.823	0.549	178	H
Tunisia	1.061	1.069	0.979	1.036	1.092	74	M
Turkey	0.943	0.964	1.139	1.015	1.039	82	M
Turkmenistan	1.053	0.585	0.952	0.863	0.651	161	M
Tuvalu	0.912	1.030	0.907	0.950	0.872	121	M
Uganda	0.690	1.455	0.555	0.900	0.745	146	L

Country	Social Index	Env. Index	Econ. Index	Raw SEE Index	SEE Index	SEE Rank	Cluster H, M, L
Ukraine	1.193	0.813	0.893	0.966	0.914	115	M
United Arab Emirates	1.125	0.168	1.539	0.944	0.857	122	H
United Kingdom	1.349	0.690	1.448	1.162	1.414	21	H
United States	1.455	0.447	1.499	1.134	1.341	31	H
Uruguay	1.221	1.081	1.167	1.156	1.399	25	M
Uzbekistan	1.029	0.898	0.731	0.886	0.709	149	M
Vanuatu	0.918	1.293	0.902	1.038	1.096	72	M
Venezuela (Bolivarian Republic)	1.041	0.790	1.209	1.013	1.033	85	M
Viet Nam	0.888	1.211	0.705	0.935	0.834	126	L
Yemen	0.595	1.232	0.721	0.849	0.615	168	L
Zambia	0.619	1.411	0.690	0.906	0.761	144	L
Zimbabwe	0.714	1.244	0.454	0.804	0.500	185	L

Table 4: SEE index in rank order

Country	SEE Index	SEE Rank	Cluster H, M, L	Population (millions)
Liechtenstein	1.934	1	H	0.036
Monaco	1.922	2	H	0.031
Norway	1.743	3	H	4.925
Switzerland	1.723	4	H	7.702
San Marino	1.677	5	H	0.031
Sweden	1.673	6	H	9.441
Andorra	1.671	7	H	0.085
Japan	1.646	8	H	126.497
France	1.619	9	H	63.126
Ireland	1.605	10	H	4.526
New Zealand	1.580	11	H	4.415
Iceland	1.538	12	H	0.324
Italy	1.536	13	H	60.789
Spain	1.533	14	H	46.455
Australia	1.532	15	H	22.606
Denmark	1.509	16	H	5.573
Germany	1.507	17	H	82.163
Finland	1.482	18	H	5.385
Austria	1.460	19	H	8.413
Israel	1.443	20	H	7.562
United Kingdom	1.414	21	H	62.417
Cuba	1.412	22	M	11.254
Netherlands	1.408	23	H	16.665
Palau	1.404	24	M	0.021
Uruguay	1.399	25	M	3.380
Greece	1.393	26	H	11.390
Belgium	1.382	27	H	10.754
Canada	1.365	28	H	34.350
Portugal	1.364	29	H	10.690
Hong Kong, China (SAR)	1.357	30	H	7.122
United States	1.341	31	H	313.085
Cyprus	1.325	32	H	1.117
Slovenia	1.322	33	H	2.035
Costa Rica	1.317	34	M	4.727
Hungary	1.314	35	H	9.966
Chile	1.311	36	M	17.270
Korea (Republic)	1.311	37	H	48.391
Latvia	1.309	38	M	2.243
Malta	1.306	39	H	0.418
Luxembourg	1.301	40	H	0.516
Lithuania	1.294	41	M	3.307
Peru	1.291	42	M	29.400

Country	SEE Index	SEE Rank	Cluster H, M, L	Population (millions)
Slovakia	1.289	43	H	5.472
Czech Republic	1.284	44	H	10.534
Montenegro	1.277	45	M	0.632
Barbados	1.260	46	M	0.274
Croatia	1.249	47	M	4.396
Tonga	1.247	48	M	0.105
Georgia	1.244	49	M	4.329
Romania	1.235	50	M	21.436
Albania	1.233	51	M	3.216
Argentina	1.221	52	M	40.765
Brazil	1.219	53	M	196.655
Dominica	1.211	54	M	0.071
Colombia	1.185	55	M	46.927
Sri Lanka	1.178	56	M	21.045
Samoa	1.163	57	M	0.184
Mexico	1.163	58	M	114.793
Poland	1.159	59	H	38.299
El Salvador	1.154	60	M	6.227
Grenada	1.150	61	M	0.105
Ecuador	1.148	62	M	14.666
Paraguay	1.146	63	M	6.568
Congo (Democratic Republic)	1.146	64	L	67.758
Fiji	1.136	65	M	0.868
Panama	1.126	66	M	3.571
Saint Lucia	1.115	67	M	0.176
Belize	1.109	68	M	0.318
Lebanon	1.106	69	M	4.259
Saint Vincent and the Grenadines	1.098	70	M	0.109
Estonia	1.097	71	H	1.341
Vanuatu	1.096	72	M	0.246
Philippines	1.094	73	M	94.852
Tunisia	1.092	74	M	10.594
Occupied Palestinian Territories	1.068	75	M	4.152
Dominican Republic	1.061	76	M	10.056
Bhutan	1.055	77	L	0.738
Botswana	1.049	78	M	2.031
Kiribati	1.047	79	L	0.103
Mauritius	1.044	80	M	1.307
Malaysia	1.041	81	M	28.859
Turkey	1.039	82	M	73.640
Marshall Islands	1.038	83	M	0.055
Bosnia and Herzegovina	1.037	84	M	3.752
Venezuela (Bolivarian Republic)	1.033	85	M	29.437

Country	SEE Index	SEE Rank	Cluster H, M, L	Population (millions)
Jordan	1.032	86	M	6.330
Bulgaria	1.029	87	M	7.446
Cape Verde	1.027	88	L	0.501
Bolivia	1.025	89	M	10.088
Azerbaijan	1.025	90	M	9.306
Gabon	1.021	91	M	1.534
The former Yugoslav Rep. of Macedonia	1.015	92	M	2.064
Serbia	1.013	93	M	9.854
Libyan Arab Jamahiriya	1.002	94	H	6.423
Honduras	0.995	95	M	7.755
Saint Kitts and Nevis	0.992	96	M	0.039
Namibia	0.989	97	M	2.324
Singapore	0.986	98	H	5.188
Guyana	0.983	99	M	0.756
Armenia	0.981	100	M	3.100
Jamaica	0.970	101	M	2.751
Algeria	0.965	102	M	35.980
Moldova (Republic)	0.961	103	M	3.545
Guatemala	0.958	104	L	14.757
Brunei Darussalam	0.952	105	H	0.406
Belarus	0.949	106	M	9.559
Maldives	0.949	107	M	0.320
Antigua and Barbuda	0.947	108	M	0.086
Bahamas	0.947	109	H	0.347
Indonesia	0.938	110	M	242.326
Morocco	0.935	111	M	32.273
Kyrgyzstan	0.931	112	L	5.393
Micronesia (Federated States)	0.925	113	M	0.112
Suriname	0.921	114	M	0.529
Ukraine	0.914	115	M	45.190
Tajikistan	0.911	116	L	6.977
Nicaragua	0.902	117	L	5.870
Thailand	0.893	118	M	69.519
Swaziland	0.893	119	L	1.203
Mongolia	0.877	120	M	2.800
Tuvalu	0.872	121	M	0.011
United Arab Emirates	0.857	122	H	7.891
Kazakhstan	0.849	123	H	16.207
Iran (Islamic Republic)	0.842	124	M	74.799
Russian Federation	0.841	125	H	142.836
Viet Nam	0.834	126	L	88.792
Solomon Islands	0.830	127	L	0.552
Egypt	0.830	128	M	82.537

Country	SEE Index	SEE Rank	Cluster H, M, L	Population (millions)
Oman	0.829	129	H	2.846
Lao People's Democratic Republic	0.822	130	L	6.288
Cameroon	0.812	131	L	20.030
Syrian Arab Republic	0.809	132	M	20.766
Cambodia	0.809	133	L	14.305
Kenya	0.804	134	L	41.610
Lesotho	0.797	135	L	2.194
China	0.795	136	M	1347.565
Kuwait	0.794	137	H	2.818
Comoros	0.793	138	L	0.754
Saudi Arabia	0.789	139	H	28.083
Congo	0.786	140	L	4.140
Sao Tome and Principe	0.785	141	L	0.169
Seychelles	0.783	142	H	0.087
Ghana	0.776	143	L	24.966
Zambia	0.761	144	L	13.475
Bahrain	0.760	145	H	1.324
Uganda	0.745	146	L	34.509
Madagascar	0.738	147	L	21.315
Nigeria	0.720	148	L	162.471
Uzbekistan	0.709	149	M	27.760
Equatorial Guinea	0.708	150	M	0.720
South Africa	0.698	151	M	50.460
Rwanda	0.692	152	L	10.943
Benin	0.689	153	L	9.100
Bangladesh	0.681	154	L	150.494
Togo	0.676	155	L	6.155
Haiti	0.674	156	L	10.124
Nepal	0.671	157	L	30.486
India	0.671	158	L	1241.492
Côte d'Ivoire	0.663	159	L	20.153
Pakistan	0.655	160	L	176.745
Turkmenistan	0.651	161	M	5.105
Timor-Leste	0.650	162	L	1.154
Qatar	0.649	163	H	1.870
Senegal	0.641	164	L	12.768
Eritrea	0.640	165	L	5.415
Sudan	0.632	166	L	44.632
Myanmar	0.621	167	L	48.337
Yemen	0.615	168	L	24.800
Papua New Guinea	0.599	169	L	7.014
Gambia	0.597	170	L	1.776
Tanzania (United Republic)	0.593	171	L	46.218

Country	SEE Index	SEE Rank	Cluster H, M, L	Population (millions)
Mali	0.591	172	L	15.840
Malawi	0.585	173	L	15.381
Mauritania	0.577	174	L	3.542
Afghanistan	0.575	175	L	32.358
Guinea	0.573	176	L	10.222
Liberia	0.564	177	L	4.129
Trinidad and Tobago	0.549	178	H	1.346
Guinea-Bissau	0.544	179	L	1.547
Central African Republic	0.534	180	L	4.487
Chad	0.529	181	L	11.525
Korea (Democratic People's Rep.)	0.525	182	M	24.451
Nauru	0.521	183	H	0.010
Ethiopia	0.504	184	L	84.734
Zimbabwe	0.500	185	L	12.754
Mozambique	0.491	186	L	23.930
Burkina Faso	0.485	187	L	16.968
Iraq	0.479	188	L	32.665
Angola	0.470	189	L	19.618
Sierra Leone	0.465	190	L	5.997
Burundi	0.423	191	L	8.575
Somalia	0.407	192	L	9.557
Niger	0.365	193	L	16.069
Djibouti	0.338	194	L	0.906

The top ten countries include nine European countries, the exception is Japan. Conversely the bottom ten countries include nine African countries with Iraq as the exception.

Robustness and sensitivity analysis

The top seven countries based on the SEE index include four countries with missing values. All four have missing values for the carbon per capita while two have missing values on two other components. Although the data set has few missing values, the fact that some of the countries affected are concentrated at the top of the table suggested that the measures and positions in the SEE index needed further investigation for these countries (Liechenstein, Monaco, San Marino and Andorra). At first it was felt that the positions of these countries might be sensitive to the method selected to impute missing values, but changing from median values to mean values for the missing carbon per capita values had little impact on position in the SEE index. All four of these countries are geographically- and demographically-small European countries and it may be that the similar position of these four does represent some particular effect. In particular, these are small countries with a high quality of society, environment and economy; and their economies are not based around manufacturing. However, their small sizes raise an issue which relates to their contribution to the overall global position. The constructed indices are based on per capital data whereas the contribution of an individual country to the global position is related to absolute figures. For example, the impact of an individual country on the global environment links to their total carbon emissions, i.e. the per capita data weighted by the population. In other words the global position is sensitive to the productivity of large countries of the world, e.g. China, but is insensitive to the productivity of the "Andorras" of this world. Therefore in the later sections of the paper we choose to look at a subset of the overall data and focus on the thirty five largest countries based on population size.

Back to the details and links to other indicators

The components of the social index are highly and significantly correlated as can be seen from Table 5.

Table 5 : Pearson correlation matrix for the social index and its components

	Life expectancy index	Mean years of schooling index	Expected years of schooling index
Social index	.891**	.906**	.927**
Life expectancy index		.685**	.743**
Mean years of schooling index			.781**

All correlations are p=.000 and N=194

***. Correlation is significant at the 0.01 level (2-tailed).*

Table 6 shows the correlation between the three components of the SEE Index. The correlation coefficients are highly significant, with the highest connections with the economic index. The environmental index is negatively correlated with the social and economic indices. One way of interpreting these relationships is that high economic performance of a country facilitates high performance on the social front, i.e. high GDP per capita leads to high investment in social infrastructure such as health care and schooling. Unfortunately achieving a high GDP comes as a consequence of a high carbon footprint, i.e. damage to the environment. A consequence of combining three separate indices with this pattern of relationships is that the variability in the SEE index is low with a standard deviation of 0.13 compared to the standard deviations of the three component indices that lie between 0.30 and 0.33 Since the environmental index is negatively correlated with the other two indices, the value of the environmental index is likely to be such that it compensates for the values of the other two and hence produces a value of the SEE index that is close to 1.

Table 6:Pearson correlation matrix for the SEE index and component indices

	Environmental index	Economic index	Social, environmental & economic index
Social index	-.731**	.845**	.869**
Environmental index		-.823**	-.414**
Economic index			.802**

All correlations are p=.000 and N=194

***. Correlation is significant at the 0.01 level (2-tailed).*

Countries were clustered based on the three component indices. First an hierarchical clustering was carried out and the results examined, including a dendogram; these suggested solutions with three or five clusters would be appropriate. A second analysis using the two-stage-clustering approach in SPSS suggested that the three stage solution would be more appropriate. Although the three cluster solution was preferred, both three and five cluster solutions were obtained from a k-means cluster analysis and examined. Details of the three clusters are given in Table 7 which shows that these clusters are roughly the same size in terms of number of countries allocated to each cluster. The clusters also map approximately to the size of the SEE index (see Table 3); the mapping is not exact because potentially different configurations of the three component indices could lead to the same SEE index.

Table 7: Cluster designations and mean index values for cluster centres

	Cluster		
	Low Performing Group (L)	Medium Performing Group (M)	High Performing Group (H)
Mean social index	.65	1.06	1.32
Mean environmental index	1.35	1.00	.60
Mean economic index	.63	1.01	1.42
Mean SEE index	0.68	1.06	1.29
Number in cluster	62	79	53

Cluster 1 contains a group of countries with high environmental indices but low values on the two other indices (see Table 7); overall this group has the lowest mean SEE index (designated the Low performing group). The group comprises countries that are, in general, at the bottom end of the SEE index and includes many central African states, India and its geographically-close neighbours (e.g. Bangladesh, Pakistan, Nepal), Middle East (e.g. Afghanistan, Iraq), and part of South East Asia (e.g. Myanmar, Lao Republic, Vietnam, Cambodia). The second cluster has countries with high social and economic indices coupled with a low environmental index; however this group has the highest mean SEE index of the three groups (designated the High performing group). This group contains the countries at the top of the SEE index and comprises many European countries and other developed countries such as Australia, New Zealand, Japan, USA, Canada, and Gulf States (e.g. Saudia Arabia, Kuwait, Oman). The third cluster comprises countries that are near the middle of the scores for all indices, overall and components (designated the Medium performing group). Included in this are South America, Central America and the Caribbean (e.g. Mexico, Jamaica), North Africa (e.g. Egypt, Algeria, Morocco), South Africa, Middle East (e.g. Turkey, Lebanon, Jordan, Iran), Balkans (e.g. Bulgaria, Bosnia, Serbia), Eastern Europe (e.g. Ukraine, Belarus), Central Asia (e.g. Mongolia, China), part of South East Asia (e.g. Thailand, Indonesia, Malaysia, Philippines).

As indicated earlier a number of "small" countries appear near the top of the SEE index. However, when examining the contribution of an individual country to the overall global position then each country's size needs to be taken into account. The SEE index is basically a per capita index and therefore selecting country population as the measure of size seems appropriate. So when considering which countries will have the major "impact" on the global position then it makes sense to consider weighting the SEE by population and to focus on the larger countries as the major contributors. It is worth observing before focusing on the larger countries that all indices, i.e. SEE and the three components, are uncorrelated with population size. In general, high and low performing countries appear at all sizes of countries. However, size does have some impact since the overall SEE index for the world when country values are weighted by population is 0.90; this suggests that, in general, large countries are lower performing than smaller ones.

The populations for the 194 countries vary from the smallest (Nauru) with a population of 0.10 million to the largest (China) with 1347.5 million; the mean country-population is 35.78 million. When the countries are organised in descending population size then 35 countries are above the mean and collectively they comprise 81.4% of the world population. Table 8 contains data on population and SEE index for these top 35 countries. Figure 4 shows the graph of SEE index vs. population for these top 35 countries.

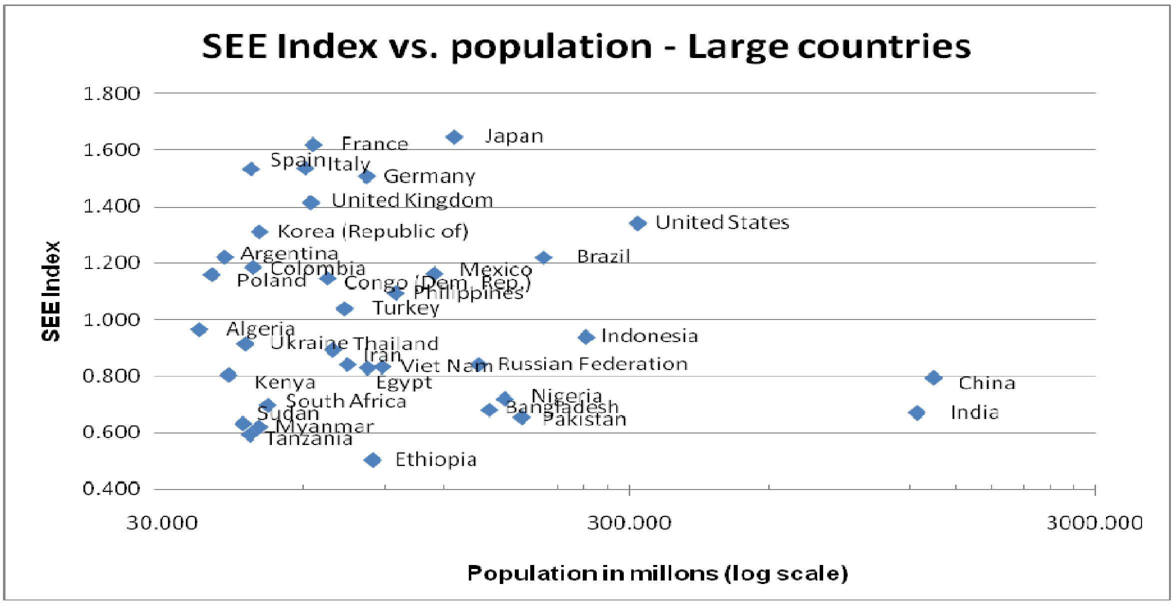

Table 8: SEE Index and population for 35 largest countries

Country	Population (millions)	Population Rank	SEE Index	SEE Rank for 35 largest countries	SEE Rank for all 194 countries
China	1347.6	1	0.795	26	136
India	1241.5	2	0.671	30	158
United States	313.1	3	1.341	7	31
Indonesia	242.3	4	0.938	18	110
Brazil	196.7	5	1.219	10	53
Pakistan	176.7	6	0.655	31	160
Nigeria	162.5	7	0.720	27	148
Bangladesh	150.5	8	0.681	29	154
Russian Federation	142.8	9	0.841	22	125
Japan	126.5	10	1.646	1	8
Mexico	114.8	11	1.163	12	58
Philippines	94.9	12	1.094	15	73
Viet Nam	88.8	13	0.834	23	126
Ethiopia	84.7	14	0.504	35	184
Egypt	82.5	15	0.830	24	128
Germany	82.2	16	1.507	5	17
Iran	74.8	17	0.842	21	124
Turkey	73.6	18	1.039	16	82
Thailand	69.5	19	0.893	20	118
Congo (Dem. Rep.)	67.8	20	1.146	14	64
France	63.1	21	1.619	2	9
United Kingdom	62.4	22	1.414	6	21
Italy	60.8	23	1.536	3	13
South Africa	50.5	24	0.698	28	151
Korea (Republic of)	48.4	25	1.311	8	37
Myanmar	48.3	26	0.621	33	167
Colombia	46.9	27	1.185	11	55
Spain	46.5	28	1.533	4	14
Tanzania	46.2	29	0.593	34	171
Ukraine	45.2	30	0.914	19	115
Sudan	44.6	31	0.632	32	166
Kenya	41.6	32	0.804	25	134
Argentina	40.8	33	1.221	9	52
Poland	38.3	34	1.159	13	59
Algeria	36.0	35	0.965	17	102

Conclusion

What has been achieved is the construction of a SEE index using a rigorous, defensible methodology. The resulting index is one that embraces the heart of the debate around this area namely that for a country's environmental performance appears to trade-off against performance in the economic and social realms. The three groups of countries which map to the high, medium and low performance on the SEE dimensions seem to square with what one would intuitively expect the members of these groups to be. Of course for some individuals the position of their country in this list could be politically embarrassing and stimulate criticism of the approach taken – we hope not. By using the well-respected OECD methodology and transparently providing details of the calculations we hope to mitigate any negative response. However, the theoretical basis of the work is clearly one that could be challenged on a number of grounds.

The social and economic components of the index are more defensible than the environmental one. For example, the social index is based on three components, whose measures are reasonably reliable, in a similar way to the UN HDI index. The economic index relies, like many such indices do, on GDP per capita – a tried and trusted measurement approach. The environment index can be criticised because it relies on a single dimension, carbon per capita, and the quality of measurement of carbon emission is still being refined. The quality of a country's environment is a complex concept that can be argued as related to intrinsic features of the country and to historical development and not just today's emissions. Nevertheless, carbon emission is the one factor that attracts a lot of attention in the current debate about protecting the environment.

The SEE index is based on 2009 data for 194 countries; although there are some limited areas where data were missing. Clearly tightening up the data availability is an area for further work. The parameters determined in the analysis allow for flexibility in that: (a) indices for later years can be calculated as data becomes available. Later indices can be compared back to the base year to monitor progress; both for individual countries but also for the world. If the mean[2] SEE index across the data set increases over time then globally we will be improving matters; a decrease will show we are slipping back. (b) SEE indices can also be calculated for earlier years, providing data are available, and a time series of yearly performance can be constructed. (c) Although the existing data set is comprehensive, some minor countries are omitted. However, any countries presently omitted could be fitted in if data were made available.

We offer in this paper a standard method for benchmarking the SEE productivity of countries, regions and the globe. We have erred on the side of simply presenting the index rather than indulging in the "blame game" of why some countries are "good" and others "bad". The method could clearly lead on to further research, e.g.

[2] Of course this assumes that averaging across countries represents the global situation when arguments could be made for weighting the average using variables such as country population.

researching what factors determine SEE performance. However in a more practical vein, this method could help focus people's thoughts and actions toward better managing our planet; whether they are members of government, policy makers, business people, environmental activists or simply the person in the street. Our hope is that we have created something that could be useful in helping to improve future conditions on planet earth.

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